REMARKS

Objections

Examiner has objected to the drawing for lacking reference numerals for opposed ends on the cylinders. Following Examiner's suggestion, Applicants have added numerals 6 and 7 to denote the respective opposed ends. The objection to the drawing is therefore overcome.

As suggested by the Examiner, the specification has been amended to correct the terminology "pump 1" to "pump cylinder 1" in all appropriate places; and on page 3, line 26 "pump 1" has been changed to "piston 5". Furthermore, reference numerals 6, 7 have been added to the specification to conform with corresponding changes in the drawing. Objections to the specification are therefore overcome.

Claim Rejections

A. 35 U.S.C. 102

Yang US 6,176,683

Claims 1-6 and 8 have been rejected under 35 USC 102(e) as being anticipated by Yang (US 6,176,102). Specifically, Examiner states that Yang discloses, among others, drive means 900 and sensor means 500, 600 "in communication with the cylinder for sensing contact of the piston and either of the opposed ends and generating a contact signal representing the contact".

Yang is directed towards an output control apparatus for a linear compressor, in which a stroke computation unit 800 is used to compute a stroke of the compressor piston based on the voltage and current received from a voltage sensor and a current sensor. A collision detection sensor 500 detects a vibration when the piston collides with a discharge valve, and the abnormal signal arising from the vibration is detected by a collision detection unit 600. A new control stroke is then determined by a microcomputer 700 based on a stroke output from the stroke computation unit at the time of vibration detection, and the new control stroke is outputted to a driving unit 900 to control the driving voltage of the compressor (see e.g., col. 3, lines 12-33).

Claim 1 has been amended to clarify Applicants' invention, in which a sensor means is used for sensing any contact between the piston and the opposed ends 6, 7 of the cylinder - i.e., the piston in Applicants' invention may, during operation, contact ends 6, 7 of the cylinder, and the sensor means is used to detect the resulting contact, regardless of which end of the cylinder the collision occurs. This finds support on page 2, line 16 of Applicants' specification as filed. Thus, no new matter is added as a result of this amendment. Applicants' amended claim 1 is different from Yang's invention for the following reasons.

Throughout the disclosure, Yang consistently refers to the piston as colliding with a discharge valve, but there is no teaching regarding where this discharge valve is located within the compressor interior. Even assuming that Yang's discharge valve is indeed mounted on one end of the compressor interior (e.g., analogous to one end of Applicants' cylinder), Yang simply has not disclosed or suggested that the piston be configured for possible collision with any opposed end of the compressor whose resulting vibration may also be detected by the sensor.

To anticipate a claim, a reference must disclose each and every element of the claimed invention. Since Yang does not teach the piston as configured to collide with the ends of the compressor interior, or that the sensor is capable of sensing any contact with the ends of the interior - e.g., sensing contact with the discharge valve as well as sensing contact with the opposed end of the interior, Applicants' amended claim 1 is not anticipated by the teaching of Yang, and thus, patentable under 35 U.S.C. 102(e).

Dependent claims 2-6 depend directly from amended claim 1, and recite additional features therefor. For the same reasons set forth above, these claims are also not anticipated by Yang, and thus, patentable under 35 U.S.C. 102(e).

Applicants' claim 8 recite, in part: "control means interconnecting said sensor means and the driver, the control means responsive to the first signal to generate a second signal to the driver to control movement of the driver and the piston" (emphasis added).

Yang does not teach any control means interconnecting the sensor means and the driver, as in Applicants' claim 8. Instead, Yang discloses (see FIG. 1 and col. 3, lines 12-33) the collision sensor 500 connected to the collision detection unit 600, which, along with the stroke computation unit 800, are connected to the microcomputer 700. The driving unit 900 connects between the microcomputer 700 and the voltage controller 100 for the linear compressor 400. It is clear that there is no control means in Yang that interconnects the sensor means and the driver, as recited in Applicants' claim 8. Instead, the sensor of Yang is connected to the microcomputer, which then connects to the driving unit. As such, Applicants' claim 8 is not anticipated by Yang, and thus, patentable under 35 U.S.C. 102(e).

B. 35 U.S.C. 103(a)

Yang (US 6,176,683)

Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Yang (US 6,176,683) because Yang demonstrates the invention claimed in Applicants' claims 1-6. Examiner's position is that the sensor and control system of Yang could have been applied to any pump or compressor system having a piston which reciprocates in a cylinder.

As previously discussed, Applicants' amended claim 1 is not anticipated by Yang. Applicants further submit that the amended claim 1 is not obvious over Yang for the following reasons.

Yang's device relies on the detection of the timing when piston and discharge valve collide (e.g., abstract) in order to allow the reset of the control destination stroke based on the input from the stroke computation unit at the time of collision - see, e.g., col. 4, lines 60-63, after collision detection signal is sent to the microcomputer 700:

> "microcomputer 700 resets the previously set control destination stroke to the current stroke based on the stroke inputted from the stroke computation unit at the moment when the abnormal signal is detected."

Not only is there no suggestion or teaching in Yang that the piston would collide with any part of the compressor interior (e.g., opposed end from the discharge valve) other than the discharge valve, but there is also no teaching or suggestion as to how a vibration signal resulting from the piston's collision with the opposed end of the compressor interior might be used in computing a control stroke. Furthermore, Applicants submit that if the piston were to collide with the opposed end, and the resulting vibration is detected by the sensor, Yang's device may not function as intended because it is not obvious as to how the microcomputer can distinguish between the timing of the collision with the discharge valve versus that with the opposed end.

Therefore, Applicants' amended claim 1 is not obvious over Yang. Claim 7, which depends directly from claim 1, is also not obvious over Yang, and thus patentable under 35 U.S.C. 103(a).

Matsumura et al. (JP 11-324911) in view of Yang

Examiner has rejected claims 1-8 as being unpatentable over Matsumura et al. (JP 11-324911) in view of Yang. Examiner further relies on consultation with the USPTO translation branch that Matsumura et al. also teaches that the sensor device can be "a MR sensor (magnetoresistive), a laser sensor, a differential transmission sensor or the like". Applicants respectfully disagree that claims 1-8 are obvious over Yang in view of Matsumura.

According to the English translation of Matsumura's abstract (no translation of the remaining Japanese document is provided to Applicants), a displacement sensor 4 is used for detecting the position of a piston. Furthermore, a control circuit 5 is used to form "the current command value in response to the position data obtained from the sensor signal processing circuit 6", and that the control circuit has "a large and small excess judgment references about position of the piston" (emphasis added), which is used to adjust the current command value that is supplied to the motor driver 3.

Thus, Matsumura teaches the use of a displacement sensor, which provides information regarding the position of the piston in order to effect proper control for a linear compressor. Nowhere does Matsumura's abstract suggest that it is desirable to detect any contact between the piston and the compressor wall.

Since Matsumura's device is designed to "eliminate a danger that a piston collides with an upper wall of a cylinder even in the case where a load is suddenly fluctuated" (see Problem to be Solved), a sensor to detect contact between the piston and the wall simply would not have been appropriate in Matsumura's control device. Thus, it stands to reason that the types of sensors that Examiner asserts are taught in the remaining, untranslated portion of the Japanese document - e.g., MR sensor, laser sensor or differential transmission sensor, must all be designed to detect displacement (i.e., position) of the piston, instead of sensing contacts between the piston and the cylinder wall, as recited in Applicants' independent claims 1 and 8.

As such, Applicants respectfully submit that there is simply no motivation to modify Matsumura's device from a displacement sensor to that of a sensor for sensing contact, as recited in Applicants' claims 1 and 8. Similarly, one skilled in the art would not have been motivated to combine Matsumura's teaching with that of Yang's because of the vastly different approaches - Yang's control device relies the occurrence of a collision between the piston and the discharge valve, while Matsumura's approach is to avoid any such collision. Therefore, Applicants submit that claims 1 and 8 are not obvious over Matsumura in view of Yang.

Furthermore, neither Yang nor Matsumura teaches or suggests a sensor means for sensing contact between the piston and both ends of the cylinder, as recited in Applicants' amended claim 1. Thus, even if both references were combined, one would not have arrived at Applicants' amended claim 1. Therefore, claim 1 is not obvious over Yang or Matsumura, either singly or in combination. For the same reasons set forth above, claims 2-7, which depend from claim 1, are also not obvious over the combination of Yang and Matsumura.

Finally, Applicants respectfully request, should Examiner believe that the untranslated portion of Matsumura's reference provide teaching different from Applicants' interpretation as set forth above, that an English translation be provided to the Applicants in order to provide a fair opportunity for a proper, objective evaluation of the full scope of Matsumura's disclosure.

In view of the amendment and the remarks set forth above, Applicants request reconsideration of the rejection and allowance of all presently pending claims. Since the claims are in condition for allowance, prompt and favorable action is hereby respectfully solicited. Should there be any remaining issues, please feel free to call the Applicant's attorney in order to expedite the resolution of these issues.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "Version with markings to show changes made".

Respectfully submitted,

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Encl.:
Transmittal Form with Certificate of Transmission
Petition for Extension of Time
Fee Transmittal
Corrected Drawing

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification

The paragraph beginning on page 3, line 8 has been amended as follows:
"As shown in the Figure, a vibration sensor 3, for example a piezoelectric device, is mounted on a machine in the form of a pump**[1]**, such that any end collision of reciprocation piston 5 is detected, for example on **[the]one** end **6** of **[the]a** pump **cylinder** 1. Vibration sensor 3 is electrically/electronically connected to a controller 2 in the form of an electronic circuit, for example a micro-processor. The controller 2 is electrically/electronically linked to a variable voltage **[drive]driver** 4 including an electromagnet which is itself mechanically linked to the piston 5 of the pump **cylinder** 1, to form a closed loop control system. The controller 2 interconnects the vibrator sensor 3 and the driver 4. The vibration sensor 3 can be mounted to an end 7 of the pump **cylinder** 1 opposite to that which the sensor 3 is shown mounted in the Figure."

The paragraph beginning on page 3, line 19 has been amended as follows:
"In use, the controller 2 is set to deliver a gradually increasing voltage across the driver 4. This has the effect of gradually increasing the stroke length of the piston 5. Should the end of the piston 5 strike an end plate at either end **6, 7** of the pump **cylinder** 1, this is detected by the vibration sensor 3 which generates a signal which is transmitted to the controller 2. Receipt of the signal from the vibration sensor 3 then causes the controller 2 to reduce the drive voltage to the driver 4."

The paragraph beginning on page 3, line 26 has been amended as follows:
"In the above described embodiment, the **[pump 1]piston 5** is driven by a closed loop control system which includes a vibration sensor 3, a variable driver 4 and a controller 2 which is used to analyze the sensor output from the vibration sensor 3 to determine the drive voltage."

The paragraph beginning on page 3, line 30 has been amended as follows:
"The vibration sensor 3 is effectively used to maximize the piston stroke by sensing any end point engagement of the piston 5 on the pump **cylinder** 1 and thereby avoid over driving the pump. The vibration sensor 3 is able to detect collision at either end **6, 7** of the pump **cylinder** 1, therefore the maximum stroke is achieved independent of any offsets in the system."

The paragraph beginning on page 4, line 16 has been amended as follows:

"- the vibration sensor 3 is not intrusive to the pump **cylinder 1** and preferably mounted to an exterior of the pump **cylinder 1** as shown in the Figure and therefore, not vulnerable to contamination or corrosive action."

In the claims

Claim 1 has been amended as follows:

1. (Amended) An apparatus, comprising:

a cylinder having opposed ends;

a piston disposed for reciprocating movement between the opposed ends of the cylinder;

drive means connected to the piston for providing the reciprocating movement of the piston;

sensor means in communication with said cylinder for sensing **any** contact of said piston and [**either of**]said opposed ends, and generating a contact signal representing said contact.